

Factors That Influence  
the Surgical Procedures and Techniques  
of ACL Reconstruction  
in College-age Athletes

An Honors Thesis (ID 499)

by

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## Introduction

The anterior cruciate ligament or ACL is one of the most frequently injured structures of the knee. Since it is easily injured, this ligament is the subject of great research. Having had training in evaluations and observing surgeries, I know the importance of this ligament to the athlete.

In this paper I will focus on many items that are involved when deciding on surgery. The bulk of this thesis will review the anatomy of the knee and ACL, some of the tests the physicians perform to evaluate the knee for a torn ACL, extra-articular and intra-articular surgeries, and the factors considered when deciding which is the best surgical technique. Other points that will be addressed are the different types of grafts, bracing, physician's philosophy, rehabilitation, and the goals and future of ACL surgery. The last question that will be answered throughout this thesis is "What factors influence the surgical procedures and techniques of ACL reconstruction in college-age athletes?"

The anatomy of the knee is complex. Four bones make up the ginglymus hinge joint of the knee (illustration #1). The femur bone meets the tibia or shin bone and fibula to make up this joint. The patella, or kneecap, a small gliding bone, sits in the groove where the femur and tibia meet (Hoppenfeld 172). The patella is not attached to any other bone. It just glides in the intercondylar notch made by the femur and tibia.

Four ligaments stabilize the knee. The medial collateral ligament (MCL) on the inside of the knee attaches the femur to the tibia. The lateral collateral ligament (LCL) on the outside of the knee attaches the femur to the fibula. The two most important ligaments are inside the joint itself. The ACL prevents the tibia from displacing anteriorly on the femur. The posterior cruciate ligament (PCL) prevents the tibia from displacing posteriorly on the femur. These two ligaments are the stabilizing forces of the knee (illustration #2 and #3).

Two menisci, or cartilages, sit in between the femur and the tibia. They keep the bones from rubbing against each other (illustration #4). The menisci absorb shock, help with the weight-bearing load of the joint, provide joint stability, aid in controlling rotation, and aid in joint lubrication and nutrition (Booher 399-400). The medial meniscus (MM) is "C" shaped and is located on the medial, or inside portion of the knee. It is attached to the MCL and to the plateau of the tibia. Its movements are restricted much more than the lateral meniscus (LM) because of its attachment to the MCL. The LM is "O" shaped and

slides back and forth. It is attached to the tibial plateau also. However, it is not bound to the LCL. The movements of this meniscus could be the reason why this meniscus is rarely torn (Hoppenfeld 179-84).

The knee also has three bursa to protect it. Bursae usually become injured and inflamed as a result of direct trauma or constant friction between supporting structures. The most commonly injured bursa is the prepatellar bursa, which lies between the front of the patella and the skin. The superficial infrapatellar bursa lies in front of the infrapatellar tendon. The third bursa, the pes anserine bursa, is situated between three tendons. These bursa lubricate and protect the knee from serious injury (Booher 406).

Finally, the muscles of the knee play a critical role in its functioning. They hold the knee together and without the contraction-relaxation process of the muscles a normal person would not be able to carry out even a simple daily activity such as walking. The muscles of the leg are diagramed in illustration #5 and #6 (Anderson 4:28-4:32).

The three movements of the knee are flexion, extension, and internal and external rotation. A healthy normal athlete should be able to bend his or her knee 135 degrees without assistance. The knee should also extend 0 degrees actively with girls sometimes hyperextending to 4-5 degrees. Internal and external rotation should also be performed without help. These two functions should go to 10 degrees each. If an athlete cannot

perform these movements on his or her own, they should be done with assistance in order for the doctor to know the extent of injury to the knee (Hoppenfeld 181-9).

Three main concepts of the ACL are important to its of origin and insertion. This means that there is always a fiber that is taut in any direction. The next concept is that the fibers are not parallel and not the same length. Finally, the fibers are not under the same tension at any one point in space (Douglas 17).

As discussed previously the main function of the ACL is to guide anterior motion of the tibia on the femur. This ligament constrains abnormal motion. The origin of the ACL is the posterolateral femoral condyle and the insertion is on the anteromedial portion of the tibia (Douglas 15). The ACL is narrowest at its most proximal portion near the femoral origin. It then fans out as it nears the tibial attachment. In full extension, the ligament is under tension, but in full flexion it is relaxed (Douglas 16).

The ACL, along with the PCL, is one of the stabilizing forces of the knee. One can live without either, but as far as being actively involved in sports, the ACL is the most important of the two ligaments. If an athlete has a torn ACL and continues to play, more damage can be done to the inside of the knee. For example, the athlete can have a major shift of the femur on the tibia and tear up the meniscus of the knee. In the early years of surgical intervention if a person had an "unhappy" triad (ACL,

MCL, MM) injury the surgeon would remove the meniscus and leave the torn ACL. Now it is thought that removing the menisci is much more damaging than not reconstructing the ACL. As one can read, the theories on the importance of the ACL to the knee have changed immensely over the years (Arnold 306). Surgeries have become more successful, and physicians have become more proficient when repairing the torn ACL.

For a physician to determine the extent of injury to the knee, a number of tests must be performed. In addition, the history of injury, the mechanism, and visual observations should be performed. Strength and range of motion (ROM) should also be checked to give a clear picture of the damage. The four tests a doctor performs to check for ACL deficiency are the Slocum Test, the Pivot Shift Test, the Anterior Drawer Test, and the Lachman Test.

The Slocum test allows complete quadriceps relaxation and greater ease of performance on a large or muscular patient (illustration #7). The patient lies with the uninjured side in a lateral decubitus position and with the lower hip and knee flexed to stay clear of the upper leg. The injured leg is on top. The upper hip and pelvis are rotated posteriorly until weight is felt by the heel of the injured leg. The knee is placed in 10 degrees flexion. It will sag into a valgus stress and the tibia will rotate internally and translate anteriorly. The examiner's hands are positioned on the lateral side of the knee. The hand nearest the foot is placed with the thumb behind the fibula and the index

finger is placed along the joint line. The other hand grasps the distal femur with the thumb over the lateral femoral condyle. While the examiner applies equal pressure with both hands, the patient's knee is gently pushed into flexion. When the patient's knee is flexed past twenty-five degrees, the anterior subluxed tibia will reduce externally, if anterolateral rotary laxity is present (Douglas 100).

The second test is the Pivot Shift Test (illustration #8). While the patient is relaxed the examiner's hand grasps the tibia at the level of the tibial tuberosity and applies a valgus stress. The other hand grasps and internally rotates the ankle or foot. This subluxates the tibia anteriorly while the examiner slowly flexes the knee. The test is positive if the examiner and client note a sudden posterior "shift" of the tibia on the femur. The only warning to the doctor is that he should not induce an osteochondral fracture (Douglas 111).

The next test used by physicians is the Anterior Drawer Test (illustration #9). The patient lies in a supine position with his or her hip flexed at forty-five degrees and his or her knee flexed at ninety degrees. The patient's tibia is in neutral rotation with the foot flat on the table (Douglas 115). The examiner's hands are placed with the fingers over the patient's hamstrings and gastrocnemius heads. The thumbs are on the tibial plateau and joint lines. The examiner gives a smooth steady pull and if the ACL is torn, the tibia distracts or pulls forward on the femur. This test is then repeated with the leg in the

internal and external positions (Hoppenfeld 185-6).

The last test is the Lachman Test (illustration #10). The patient's knee is flexed at twenty degrees. The examiner stabilizes the femur by grasping the distal thigh just proximal to the patella. With the other hand, the examiner grasps the tibia just distal to the tibial tubercle. The examiner then applies firm pressure to the posterior aspect of the tibia in an effort to produce an anterior translation. A positive result of this test is one where the tibia moves anteriorly on the femur. This test is the most sensitive of the four because the knee is held in a comfortable position for the patient. Also, the mechanical advantage of the hamstrings is ruled out and the contact area on the lateral tibia plateau is slightly convex. These three factors reduce the coefficient of static friction, thus making the Lachman Test easier to perform with clinical forces (Douglas 113).

After the initial examination by the physician, the patient has two options--to have surgery or not to have surgery. The physician must also decide if a patient with an ACL injury will benefit from surgery or will respond favorably to a more conservative treatment. The dilemma remains with regard to which patient will respond to rehabilitation and activity modifications or will progressively deteriorate with a nonoperative approach. Obviously many factors affect which option is best for the patient. Whatever type of treatment is chosen, the patient must play an active role. This choice is not an easy one to make.



The first option is nonoperative. If the patient chooses this nonevasive treatment, he or she must be educated on the ACL and its functions. He or she must also go for therapy, wear a brace, and modify his or her activity level. Previous reports received indicate a large percentage of patients do very well with this type of management if they are willing to change their lifestyle (King 115-6). Since we are considering the active individual, this is not a desirable option.

One of the options involved in this first choice is a knee brace. Bracing is one of the many modes for treating an ACL injury. Knee braces provide increased stability for the knee. The most popular brace at Methodist Sports Medicine Center is The Indiana Knee Orthosis (IKO) brace. This brace reduces rotation and abduction/adduction (MSMC brace handout). Although most patients with unstable knees feel more confident with the brace, no major benefit of the brace is apparent. The main determinant of function is muscle strength, therefore, it is necessary to rehabilitate the whole leg instead of only the thigh. Most physicians prescribe using a brace to help the patient return to activity (Tegner 265). Once the patient achieves full muscle strength, full range of motion, has little or no pivot shift and lachman, Dr. Matchett, an orthopaedic surgeon from Muncie, does not require continuing the use of the brace (Matchett interview 1990). However, Dr. Habansky, another orthopaedict surgeon from Muncie, lets the patient decide whether to continue using the brace. If the patient elects to use the brace, Dr. Habansky

usually discontinues it after one year (Dr. Habansky interview 1990).

Before bracing can be ruled out, many important factors must be explained and considered. First, the post-operative rehabilitation is hampered by increased pain and decreased ROM. Also, the aggravation of the patella causing chondromalacia or patellar tendinitis in the long-term follow-up is associated with this surgery. Because of these surgical consequences, bracing might be a viable first option.

A surgeon who considers ACL reconstruction on an athlete must account for the patient's age, the sport of the patient, the position held by the patient, and his or her own expectations and motivations (Douglas 171). The risk of reinjury to the athlete varies with the specific sport. In some of the more demanding high risk sports such as football, basketball, and gymnastics, reinjury is more possible than in a less demanding sport like snow skiing, tennis, or softball (Douglas 171).

Three determinations need to be made when a physician is deciding what type of surgery to perform. The questions the physician should ask are: 1) Can the patient modify his or her activity levels and rehabilitate the knee by nonoperative treatment? 2) Will the patient benefit from a surgical procedure? and 3) Which surgical procedure is appropriate when surgery is indicated (Douglas 172).

Since most people, particularly athletes, are not willing to give up an active lifestyle, surgery is usually the choice. The

surgery that is most commonly performed today is open reconstruction. In conjunction with an ACL tear, a patient may have a meniscal tear, articular cartilage damage, chondromalacia, or other ligamentous tears such as a torn MCL or LCL. Depending on the extent of damage, all of these can be repaired through arthroscopy. Arthroscopy is a unique way of repairing meniscal tears or chondromalacia of the knee through small incisions. To perform this procedure, the surgeon uses special instruments along with a microscopic camera. This surgery, however, does nothing to repair the torn ACL.

The selection of what type of procedure used to surgically repair the ACL, either intra-articular or extra-articular, depends on numerous factors. These factors include if the injury is acute or chronic, the patient's age and sex, the patient's activity level, the degree of instability, the patient's future athletic expectations, and the present level of disability. Athletic individuals possess greater muscle mass and strength levels so they are usually the best candidates for intra-articular repair (Douglas 138). Extra-articular repair is really no longer an option for the active individual. Most physicians prefer performing the intra-articular procedure because of the good results (Douglas 225). However, extra-articular will be discussed for reference only.

The most successful extra-articular surgical technique used is the Arnold-Kocker sling about the fibular collateral ligament to Gerdy's tubercle. "In this repair method, a strip of

iliotibial band is isolated. This fascial strip is passed beneath the LCL and doubled back on itself. It is sutured firmly at the LCL and back onto itself as it passes back toward Gerdy's tubercle (Douglas 134). Although this is the most successful extra-articular surgery, no single technique can be determined to be the best because no comparative studies have been performed (Douglas 134-5).

The goal of the extra-articular procedure is to prevent the anterior subluxation of the lateral tibial plateau in relation to the lateral femoral condyle. Placement of the extra-articular portions of the iliotibial tract is crucial in realizing this goal. The iliotibial tract acts as a reinforcement against anterior subluxation of the lateral tibial plateau. In this position it parallels the course of the ACL and may, therefore, be considered an extra-articular ACL repair.

Extra-articular reconstruction procedures are an important consideration for the non-athletic individual. Most physicians will only consider this type of surgery on a child with open growth plates. Intra-articular repair is not chosen because if holes are drilled through the growth plate, it causes early closure of the plates, and results in altered growth (Matchett interview 1990). Dr. Shelbourne, a knee specialist at Methodist Sports Medicine Center, says that the major benefit of this surgical procedure is eliminating shifting, thus making the knee more stable. Since the joint is under so much pressure from the graft, the risk of this surgery is that the joint wears down

faster, therefore causing degenerative changes (Shelbourne talk 1990).

Dr. Matchett has a different opinion of extra-articular repair. He says "They (extra-articular) do not provide the stability that an intra-articular technique does, and so I cannot count on it to be a stable operation for the patient. It may cut down on the pivot shifting, but it may not, and it rarely eliminates his or her lachman, so they are still having a lachman and can still tear their meniscus" (Matchett interview 1990). The degree of pivot shift is a major factor in helping the orthopaedic surgeon decide upon the surgical technique. As it stands, physicians seem to be moving in favor of the newer intra-articular procedure, after years of performing extra-articular techniques.

The other option for a surgeon is the intra-articular ACL repair. According to Dr. Matchett "...if a patient has a significant lachman or pivot shift and has desires to be physically active, I would recommend intra-articular because it is a more predictable operation with the way we are doing it now..." (Matchett interview 1990). Intra-articular is recommended in specific situations. These include a cruciate ligament injury in a highly athletic individual, a physically active individual with functional instability and an unwillingness to alter his or her lifestyle. Other symptoms when intra-articular is recommended include when the patient is having frequent problems of instability with activities of daily living,

episodes of effusion, and when the patient is reporting instability episodes after six months of intensive rehabilitation. The patient's level of activity and willingness to alter his or her lifestyle is a major influence in choosing the appropriate method of management (Douglas 135).

Acute reconstruction should only be done after the patient has an understanding of the time commitment for rehabilitation. For the best results, surgical reconstruction should be within seven to ten days after injury. If the patient waits any longer there is a chance for complicating the initial injury with other injuries (Douglas 135). Intra-articular surgery is done by excising the medial one-third of the patellar tendon near the proximal end. It is then rerouted from its distal insertion through the joint cavity. It is anchored to the lateral condyle of the femur and the tibial condyle with intercondyloid screws or buttons (King 117). Rehabilitation needs to be started as soon as possible to avoid the common problems associated with this injury such as loss of extension and accumulation of scar adhesions.

The physician's decision focuses on the type of graft: either an autograft, an allograft, or a prosthetic ligament should be used in surgery. There are many criteria for an ideal ACL substitute. The substitute should duplicate the physiologic function of the ACL and the graft should be non-immunogenic to the host. The graft should also present no increased susceptibility to infection and there should be an absence of

associated hyperplastic transformation. The substitution should also restore immediate stability and allow for immediate motion. The graft should be readily available in many sizes, have ease of implantation, and the material should be amenable to long-term storage (Douglas 211).

The use of the patient's own tissue, an autograft, is preferred in ACL repairs since immunogenicity is practically nonexistent. Graft incorporation is also predictable (Douglas 211). Autografts of soft tissue with their attached bony insertions offer biological material with structural advantage in replacing the ACL. The portion of the patellar tendon with bony attachments is the most popular graft (Clancy 184). The advantage of this graft is that it can be transferred with some blood supply still intact. Another advantage is that no diseases can be transferred and infection possibilities are almost nil (Douglas 193). Some other replacements used in this surgery are the gracilis tendon, the fascia latae, or the semitendinosus.

The second type of graft is an allograft, a freeze-dried patellar tendon or ACL taken from a cadaver. The best substitute is another ACL because it is anatomically correct. Other ligaments that can be used are the flexor hallucis longus, the posterior tibialis, the toe extensors, the fascia latae, or the achilles tendon (Wainer 200). Information on human allografts is limited at the present time, but data does support observations made in animals.

One factor that doctors are investigating is the immune

response. The threat of AIDS and other bodily diseases is of real concern to the medical profession. There has been one reported case of transmission of HIV from a transplanted organ, but no reported cases of transmission from nonperfused tissue such as freeze-dried bone, tendon, or fascia (Wainer 294). In an interview with Dr. Habansky, he revealed "When they can prove to me there is no AIDS, that (allograft repair) would be great (Habansky interview 1990)." This possibility of transmission has not been completely explored and will continue to be an area of research in the future. The only concerns about an allograft itself are the revascularization of the ligaments and the fibers remaining functional as they are replaced. Also, a question arises that if the graft loses this orientation, is it weaker than the original ACL?

The third graft that can be used for a substitution of the ACL is a prosthetic ligament. A prosthetic ligament is a man-made graft that will duplicate the characteristics of the original ligaments. Dr. Matchett states that research indicates that prosthetic ligaments cause a foreign body reaction and they cause a knee to carry chronic effusion or swelling (Matchett interview 1990). The current interest in prosthetic ACL reconstruction is partly due to the poor results obtained with a late reconstruction of the ACL injury (Tremblay 88). Some of the true prosthetic ligaments are Leeds-Keio, Proplast, and Gore-tex. Some augmentation devices are Dexon and the Kennedy LAD (Douglas 247).



The Leeds-Keio graft is made of polyester fiber that is woven into a small tube. Placement of this ligament is isometric through the femoral and tibial drill holes. Each end is then secured with bony plugs. The technical factors concerning placement and site preparation are important for this artificial graft survival. It has since been shown that polyester is degraded by the body over time (Douglas 248).

Another true prosthetic ligament is Proplast. This graft is a stent made of many polyaramid fibers imbedded in fluorinated ethylene propylene copolymer. The stent is coated with proplast, a vitreous carbon fiber and polytetrafluoroethylene composite, to facilitate tissue ingrowth. Like Leeds-Keio, many problems are found when working with this graft. These problems, combined with the inherent stiffness of the prosthesis led to failure of the majority of ACL grafts (Douglas 250).

The Gore-tex graft is made from a single fiber of expanded polytetrafluoroethylene. The fiber is braided to form an eyelet at each end of the graft. The braid allows even load distribution through the prosthesis. This graft is designed to restrain subluxation but not to duplicate the normal ACL. Its strength and stiffness make the technical aspects very important. The graft material fixation is bony so immediate mobilization is possible. Early reports show its use in humans as promising (Douglas 247).

Gore-tex has some key advantages over other prosthetic ligaments. It is two to three times the strength of a normal

ligament and it does not have to depend on the blood supply of a normal ligament. Also, it allows for reduced rehabilitation time. Finally, Gore-tex material has a good safety record. Since there is no living tissue in a Gore-tex graft, the synthetic ligament can simply be removed if the graft fails and another autogenous repair attempted (Lubell 154).

Dexon and the 3M/Kennedy Ligament Augmentation Device (LAD) are two augmentation devices possible for knee reconstruction. Dexon is biodegradable and is made of braided polyglycolic acid. It was found through studies that pure dexon grafts fray too quickly for use in humans (Douglas 251).

The LAD is used in a modified MacIntosh/Marshall procedure. It is sutured inside the tubes autogenous tissue graft, starting at the origin of the patellar tendon and ending at the terminal portion of the rectus femoris. This augmentation device is designed to protect the graft from excessive stress during early healing. The initial reports from this graft are good but when closely analyzed they are no better than when a graft of high initial strength is used (Douglas 251-2).

Each physician has a different philosophy of ACL reconstruction and rehabilitation. The opinions are many and varied as to what should be stressed during each phase. However, most physicians are only now understanding the benefits of an accelerated rehabilitation program. The main overall goal of every physician should be to get the patient to return to activity with a stable knee. Two doctors, Dr. Matchett of Muncie

and Dr. Shelbourne of Indianapolis have basically the same philosophy of surgeries but each stress different areas in rehabilitation.

Dr. Shelbourne is always thinking of ways to improve rehabilitation. His goals are to achieve full extension without complications. The person who does gain extension without having a complication will return faster than the one with additional trauma. Post-surgical complications can be defined as things that go wrong with a joint such as patella-femoral pain, patellar tendinitis, a flexion contracture, general aching, or infection of the graft. After the soft tissue heals, Dr. Shelbourne also wants the patient to be able to achieve ninety degrees of flexion and quad control. The argument now is that with the closed-kinetic (weight-bearing) accelerated rehabilitation, the graft will stretch. Dr. Shelbourne believes if the graft is placed correctly, it does not stretch. He states that we cannot prove the graft does not stretch because of the KT1000 scores. These scores are too sporadic. Once we can get an objective test, this theory will be proven (Shelbourne talk 1990).

Dr. Matchett believes his goals should be the same as the patient's goals. His main goals are to restore stability, to maintain full range of motion, and to not cause additional damage or trauma to the knee. However, since the surgeon takes the middle third of the patellar tendon, they are causing additional trauma to the knee. This trauma is controlled with modalities and upon re-examination of the patellar tendon it has hypertrophied

to its normal size. This usually takes around one year (Matchett interview 1990).

Another concern of the physician is full extension. Without it, the patient looks like he or she is walking with a limp. Full extension depends on proper placement of the graft. Both the tibial and femoral tunnel have to be correct and have adequate notchplasty. Although the knee feels better bent, if the patient does not get extension, he or she will never have it. Also, if the patient does not maintain extension, scar tissue and adhesions build-up and they lose extension. The surgeon then has to go back into the knee to clean up the scar tissue and adhesions so the patient can return to full extension. Flexion is not as important because it will always return as long as one works on it in rehabilitation (Matchett interview 1990).

Rehabilitation is restoration of the patient to the level of his or her pre-injury fitness. This can be accomplished through exercise and active physical therapy. Between the two surgeries, rehabilitation is mainly the same; however, with an extra-articular repair the patient can do more open-kinetics (non-weight bearing). This is because the therapist is not worried about causing patellar tendinitis since the surgeon did not have to remove one-third of the middle of the patellar tendon. Since most athletes have intra-articular repair, the rehabilitation will be adapted to that type surgery.

Rehabilitation is a time consuming project that takes from six to nine months for the ACL patient. Rehabilitation following

intra-articular ACL reconstruction consists of numerous phases. Depending on the individual progress of each patient, it is possible to overlap the following phases.

Rehabilitation begins before surgery even takes place. Since most surgeons wait at least one week to ten days before repairing the torn ligament, the patient begins the process of getting the knee stronger for surgery. The goals of this phase are to decrease swelling, increase ROM and quad strength. This way they will be one step ahead when they come into physical therapy after surgery. The stronger athletes are when entering surgery, the stronger they are when they come out.

The first phase after surgery lasts from post-op day one to day six. The patient begins continuous passive motion (CPM) the day of surgery. The heel is elevated on towels while in the CPM to ensure terminal extension. The flexion angle is increased as tolerated. The patient will perform range of motion exercises two to three times daily. The knee is allowed to extend to terminal extension for at least thirty minutes during each exercise routine. The knee is also flexed ninety degrees by sitting on the side of the bed. The patient is permitted to weight bear as tolerated with or without crutches using a dobi, which is a straight leg cast, or an immobilizer. The patient will then be discharged from the hospital three to four days after surgery (MSMC 2).

Phase II begins on the seventh day and continues through the tenth day. The patient will return for a follow-up visit to the

physician and start physical therapy during this time. The goal of this phase is for the patient to achieve terminal extension to ninety degrees flexion. Early terminal extension is the key to a successful result due to what was discussed earlier in this paper. To push extension, the patient will perform towel extension and prone hangs. Wall slides, heel slides, and active assistive flexion over the edge of the table will also be started during this phase. These exercises will help restore flexion (MSMC 2).

All of the strengthening exercises performed will be closed-kinetic (weight-bearing) exercises. It is believed these exercises help to preserve the patella-femoral joint and do not add stress to the ligament, in effect preventing patellar tendinitis. These exercises also help to facilitate early return of quadriceps strength with minimal stress to the graft. The patient will start with bilateral knee bends and calf raises and progress to unilateral exercises. The athlete is also encouraged to progress from partial to full weight bearing without crutches. He or she will also decrease the use of the dobi and emphasize normal gait. Early quad strength and early terminal extension set the pace for the entire rehabilitation program and a successful outcome (MSMC 3).

Range of motion continues to be stressed during Phase III, comprised of weeks two through four. The revised goal of this stage is to achieve terminal extension to 110 degrees flexion. The patient can begin 2-4" lateral step-ups and unilateral calf

raises. Weight room activities such as leg press with knee flexion angle no greater than 90-100 degrees, 1/4 squats, and stairmaster can begin three to four weeks following surgery. Biking and swimming workouts can also help with flexion and strength (MSMC 3).

The patient should have attained terminal extension to 120-130 degrees flexion by Phase IV which lasts from week 6-8. Weight room activities are continued while adding the hip sled. A cybex test is performed five to six weeks after surgery. There is a twenty degree terminal extension block and anti-shear device at speeds of 180 and 240 degrees per second. This test compares the quad strength in the injured leg to the uninjured leg. If the patient's quad strength is seventy percent or greater, he or she will be permitted to begin light functional progression. This includes lateral shuffles, carioca, and jumping rope. These activities are performed while wearing the brace. A KT1000 test which checks ligamentous stability is also performed at this time (MSMC 3-4).

Phase V starts at twelve weeks, and the patient has a check-up every four to six weeks. A cybex test and KT1000 evaluations are performed at this time. At twelve weeks, the twenty degree block is removed from the cybex test. As the patient's strength continues to improve, the agility workouts become more vigorous. The patient is allowed to begin figure 8's, backward running, and progress from half to full speed activities (MSMC 4-5).

From sixteen to twenty-four weeks, Phase VI begins. The

patient is followed every month. Cybex testing is monitored with slow speed testing initiated. As the patient improves he or she may resume non-contact sports around four to six months and contact sports at six to eight months after surgery. The criteria used in making this determination includes eighty percent strength on each isokinetic speed on the cybex machine and the successful completion of the functional progression. The patient is encouraged to wear the activity brace up to one year after surgery.

Many factors contribute to successful, and complete, rehabilitation following ACL knee reconstruction. Each patient is different, as are their needs and levels of activity. For these reasons, each rehabilitation program must be individualized to fit the patient's needs. The four main variables involved in rehabilitation include: the patient's desire to return to competition, the self-motivation to complete the rehabilitation process, the patient's pain threshold, and attaining the goals set by the patient. Without the athlete having these four qualities, he or she could never return to pre-injury status and would have a tough time getting through rehabilitation and back to his or her sport.

The future of ACL surgery is important to consider. Clinicians realize two principles: 1) that the ACL is an integral part of normal knee function; and 2) a knee without this ligament can be improved with a successful replacement (Douglas 291). Dr. Habansky and Dr. Matchett both agree that the future lies in



allografts. Although much more research needs to be done to achieve these goals, Dr. Matchett maintains that there will be refinements in all grafts and surgery through smaller incisions (Matchett and Habansky interviews 1990). However, the basis of any treatment, disregarding the surgery, will still be accurate diagnosis of all the manifestations of the ACL deficient knee including assessment of associated injuries (Douglas 293).

## Conclusion

As one can see the ACL is of major importance in the functioning of a healthy normal knee. To be able to function without limitations, the active individual needs to consider surgery to correct the unstable knee. Research is still being compiled, but as of now, the best graft replacement is the middle one-third of the patellar tendon with bony plugs. Along with many other considerations bracing, physician's philosophy, and rehabilitation are very important factors when looking into surgical intervention. But the primary factors deal with the athlete: pain threshold, desire, mental stability, self motivation, and reaching attainable goals set by the physician, physical therapist and the athlete. If the athlete has a strong desire and motivation to return to his or her sport, he or she will complete the rehabilitation process and return ready to play.

In addressing the primary issue this thesis is based on, the main factors that influence the surgical procedure and techniques of this surgery are the athletes active involvement in rehabilitation, the surgical procedure used by the doctor, the physician philosophy, and the athletes' mental motivation. All of these factors play a major part in the repair of an athlete's knee.

## BONES OF THE LEG

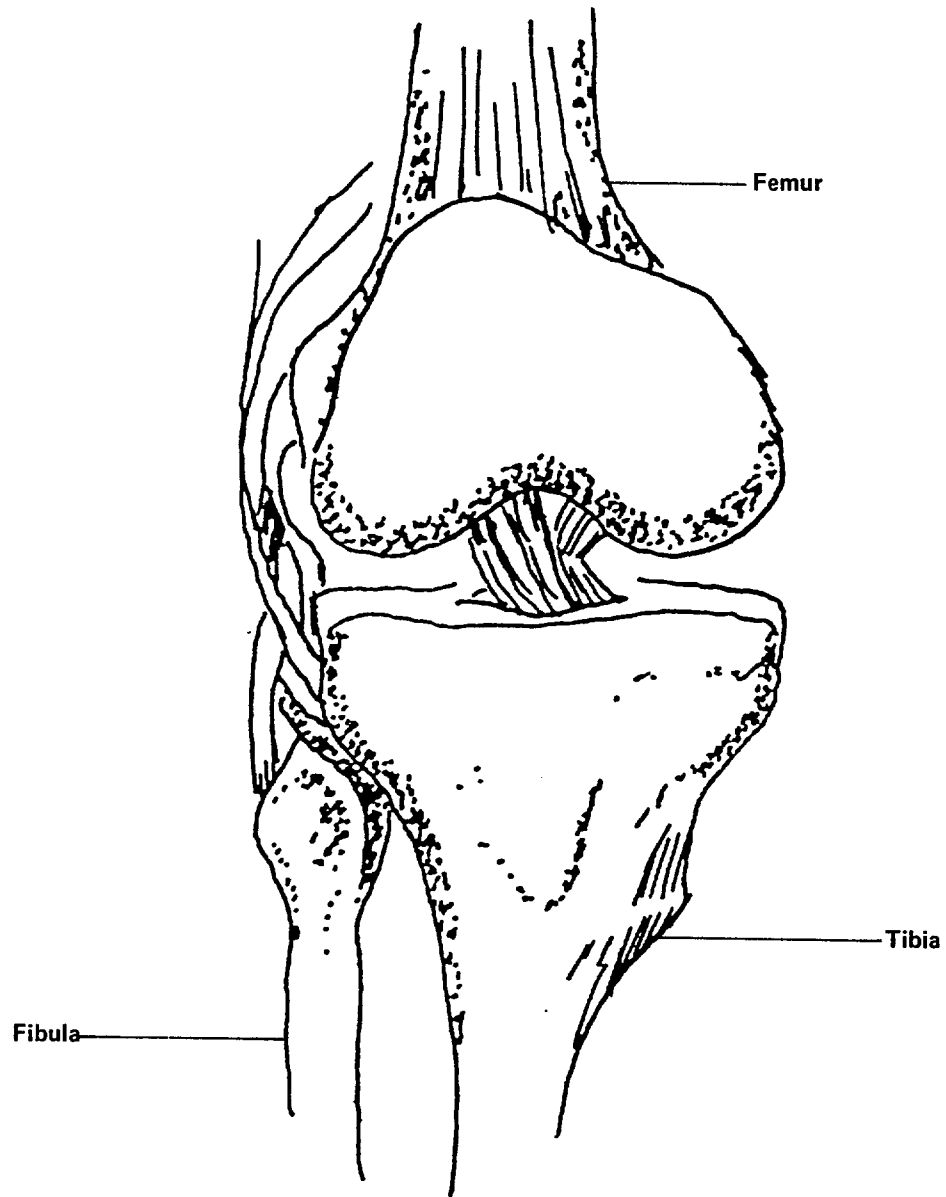


Illustration I

LIGAMENTS OF THE KNEE JOINT  
ANTERIOR  
VIEW

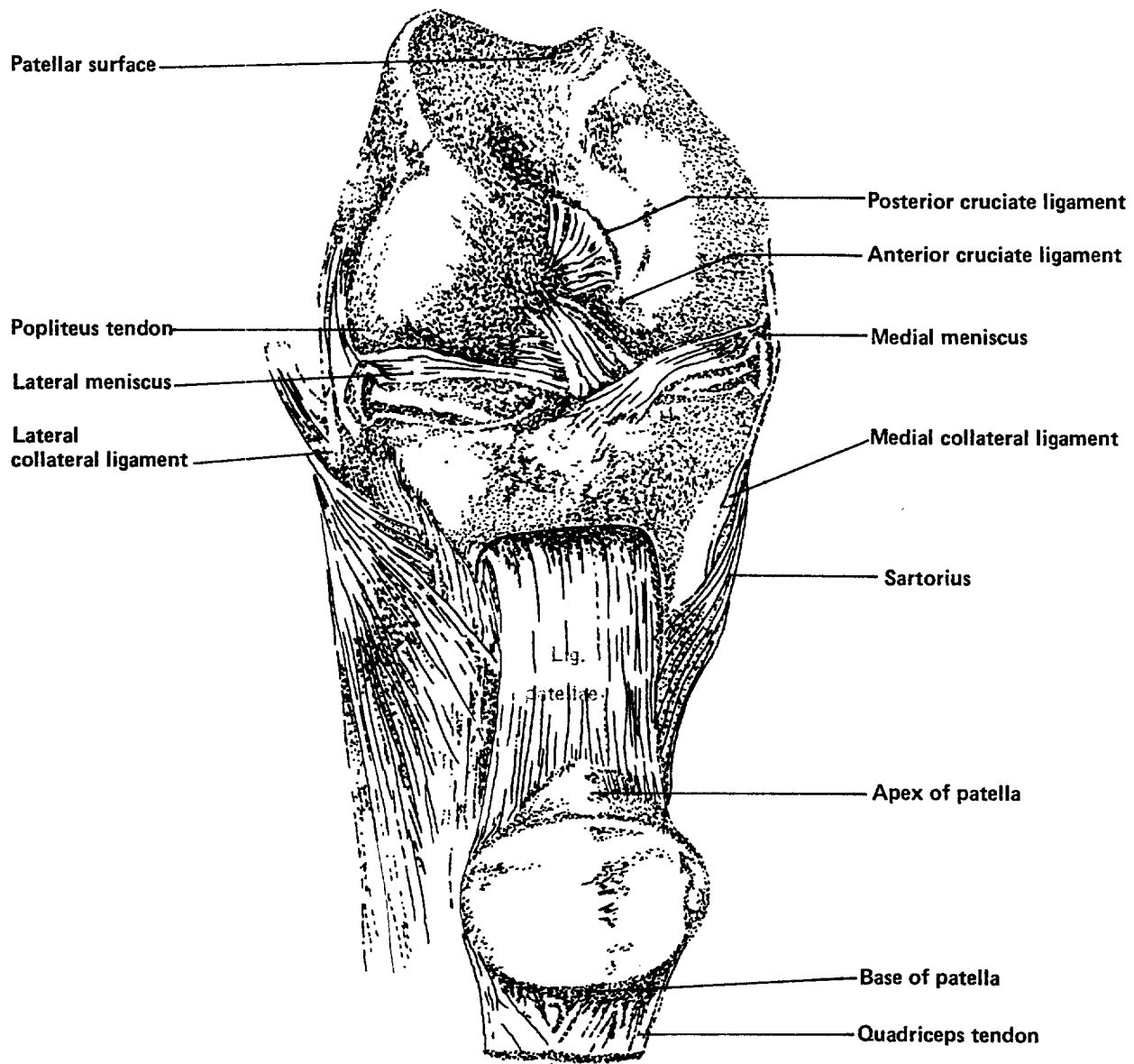


Illustration 2

## LIGAMENTS OF THE KNEE JOINT

POSTERIOR  
VIEW

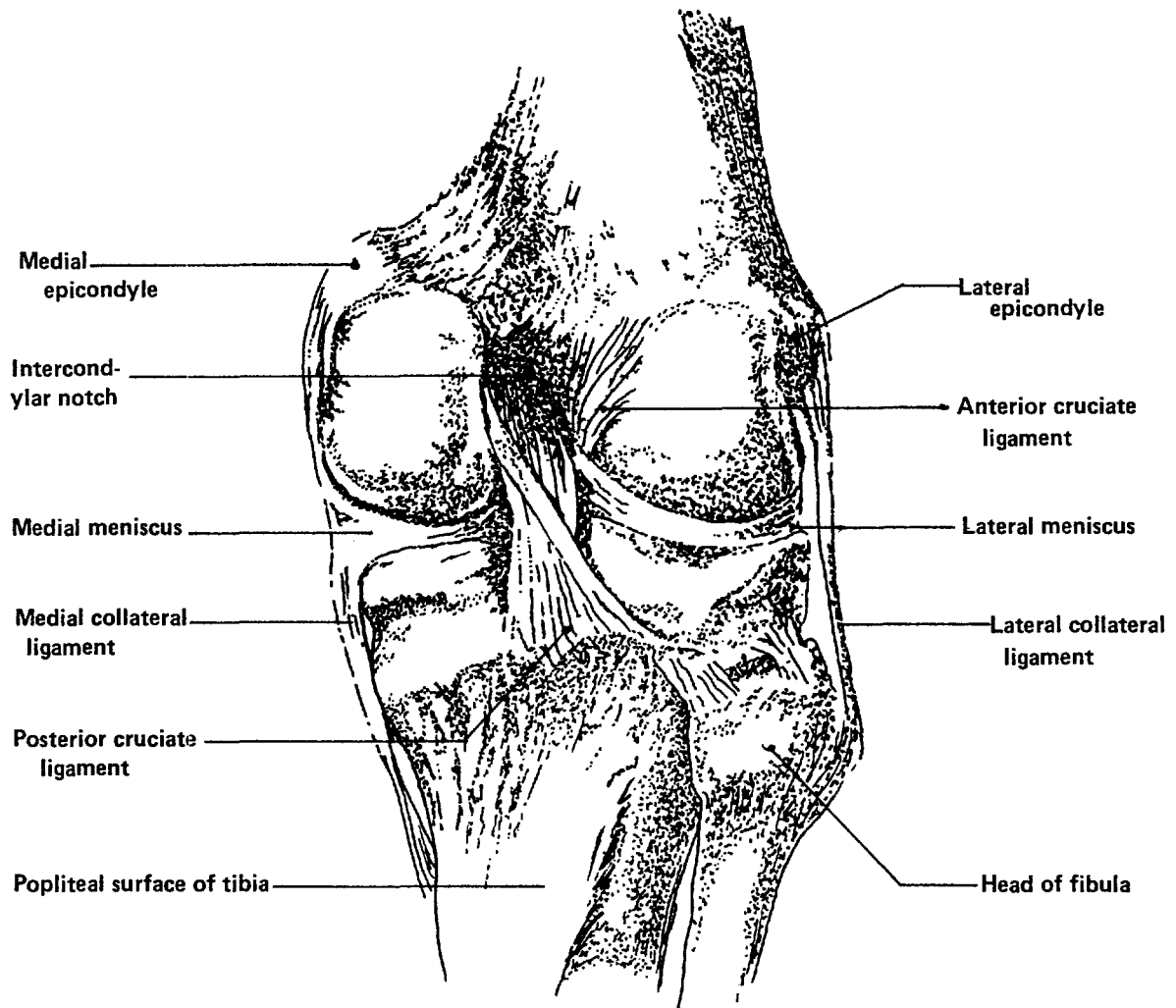


Illustration 3

## THE KNEE

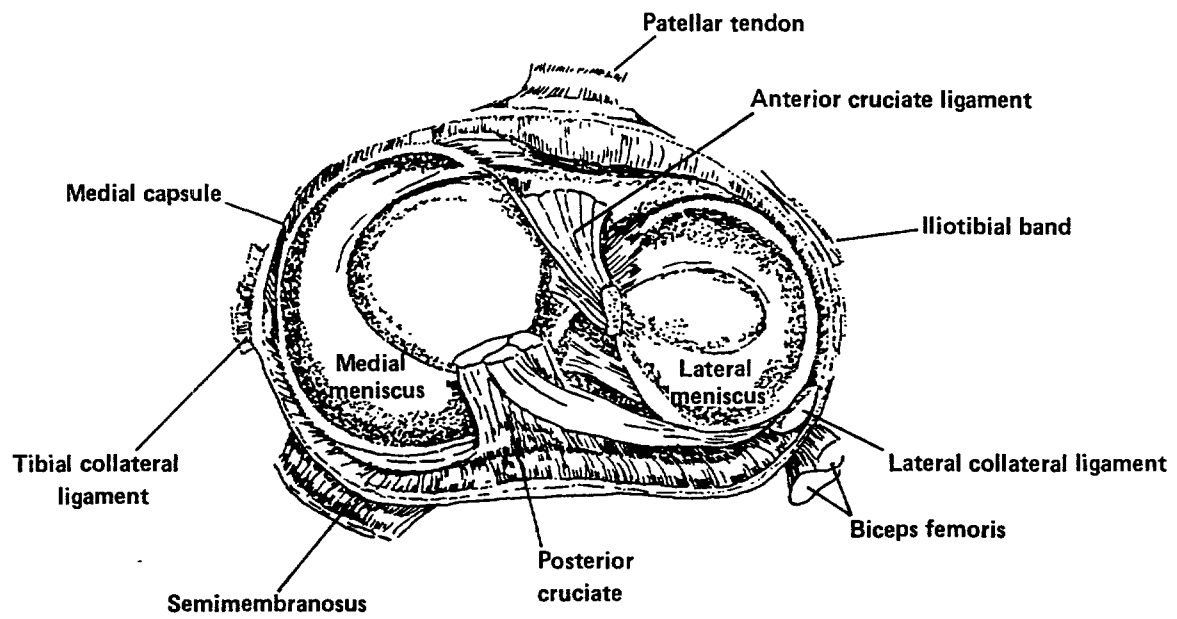


Illustration 4

## MUSCLES OF THE LEG

### ANTERIOR VIEW

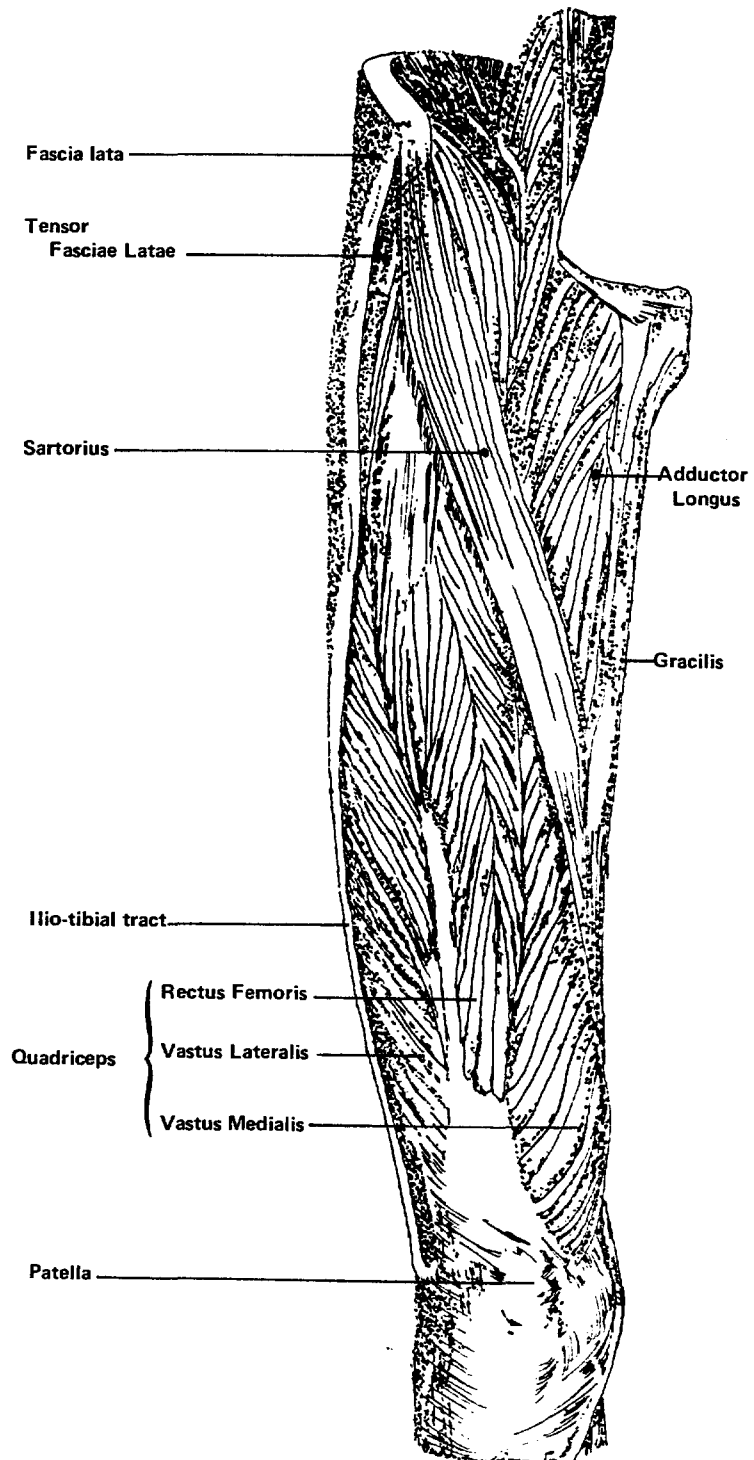


Illustration 5

# MUSCLES OF THE LEG

## POSTERIOR VIEW

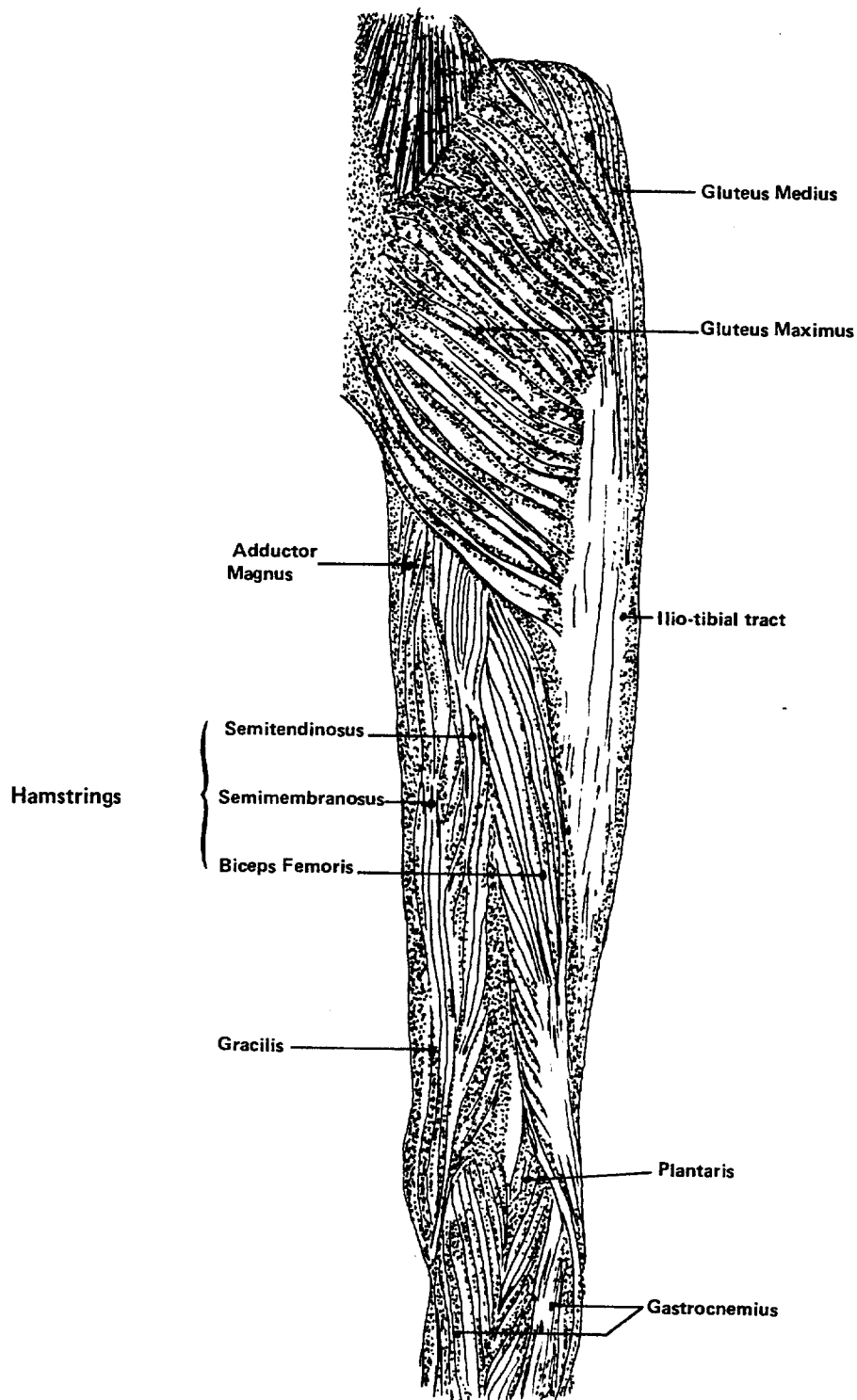
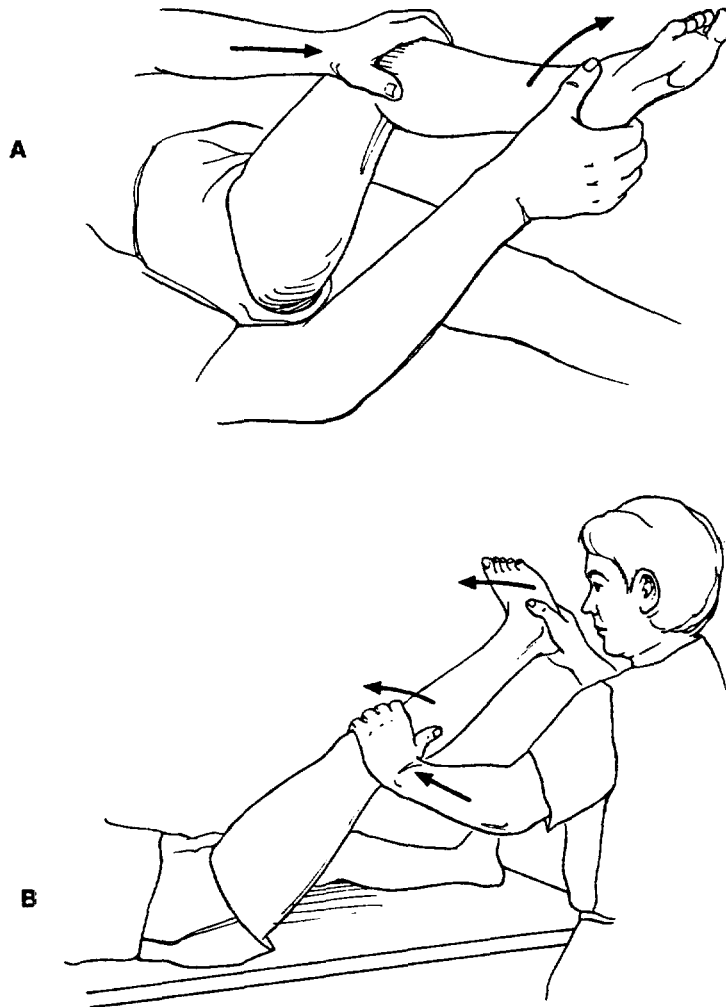


Illustration 6



**PIVOT - SHIFT TEST  
PERFORMED ON RIGHT KNEE**



**Illustration 8**

# SLOCUM TEST

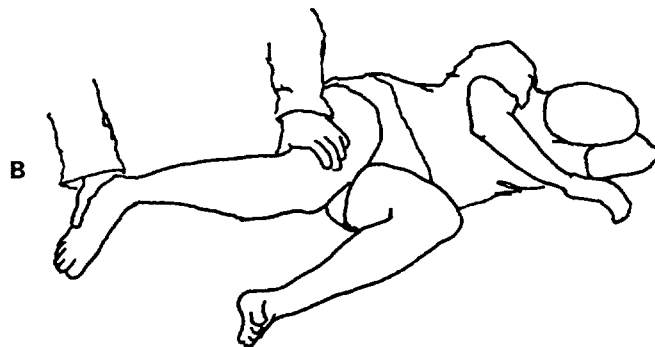
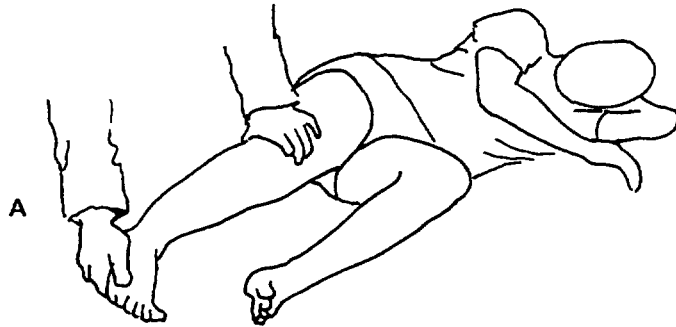
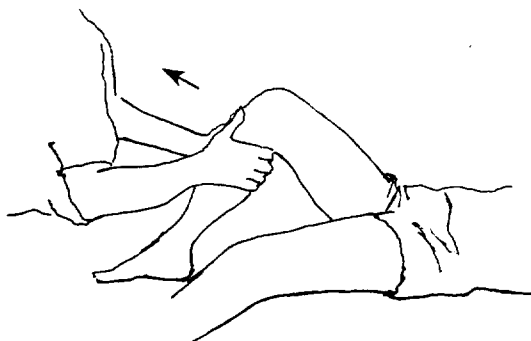


Illustration 7

### ANTERIOR DRAWER TEST



### ANTERIOR DRAWER TEST – FOOT POSITIONS

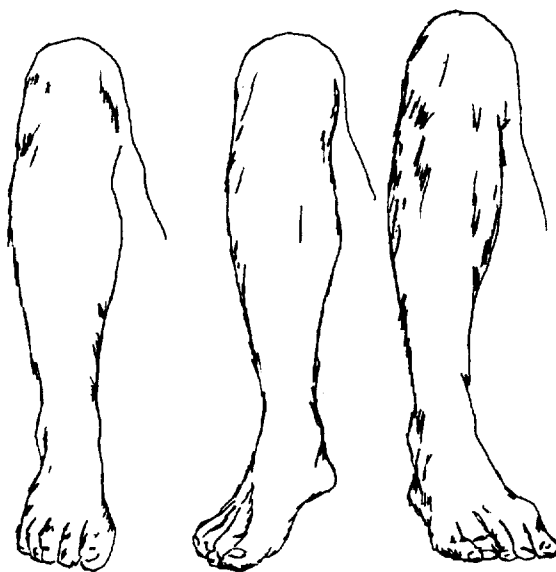


Illustration 9

## LACHMAN'S TEST

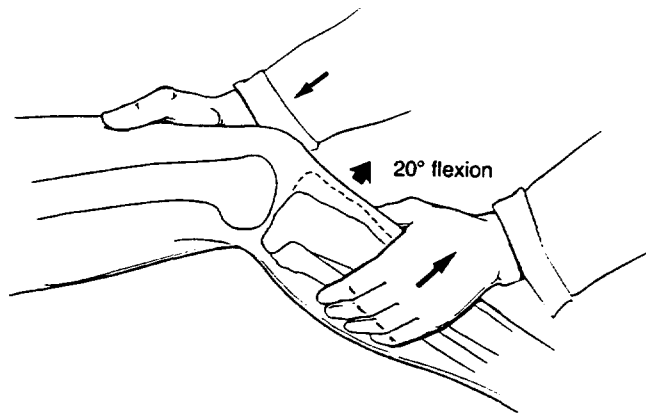


Illustration 10

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